CHAPTER X

PIANA DEGLI OSSI (ARCHAEOLOGICAL ZONE "B") MOUNT LUARIO AND THE PASSEGGERE PASS

1 – Our intuition regarding the existence of the kilns and the first analyses

After the finds on mount Bastione, we continued our search southwards along the ridge. Perhaps some centuries ago, near Faggeta and a disused farmhouse not far off called "I Capannoni" [the sheds], numerous pastures and crop fields had been claimed from the woodland. These fields are now large meadows and some are still cut to make hay.

The fields now used as pastures near the ridge above "Capannoni" *look over the Apennine chain and are visited by numerous groups of tourists walking along the route of the Roman road.*

Piana degli Ossi: *the basin-like shape of the ground cleared of trees and the hollows on the northwest side aroused our curiosity.*

The fact that these fields were farmed until the 1950s destroyed any hope of finding the remains of the road; undoubtedly, any paving stones from an unused road would have been re-cycled by the locals.

Indeed, we found absolutely no trace of the road in this area.

Beyond these fields, the beech wood reasserts its command. A little further on, always along the ridge, we found scant remains of paving about 60-70 metres north of Piana degli Ossi. Although scant, these remains are important because they confirm that the road continued in that direction.

The place name “Piana degli Ossi” [Plain of Bones] is curious for its reference to human or animal remains. Furthermore, its position (1,062 above sea level) near the road does not feature any arboreal vegetation. The plain is elliptical and lies along a north-south axis; it features a series of furrows and spurs on the west side that could resemble common graves, and which anyway are obviously manmade. We hoped we would find traces of burials.

After carrying out a few sample excavations in various points, to our surprise we uncovered small pieces of white material whose shape could, at first sight, be mistaken for bone. Once the soil covering these items had been cleared away, we realised these were fragments of limestone. The pieces varied in size, had a perfectly smooth surface and rounded edges.

Piana degli Ossi: *limestone residues which were not completely fired by the heat of the limekilns. There are many such residues on Piana degli Ossi and in the past, they were mistaken for bones, thus explaining the place name given to the area.*

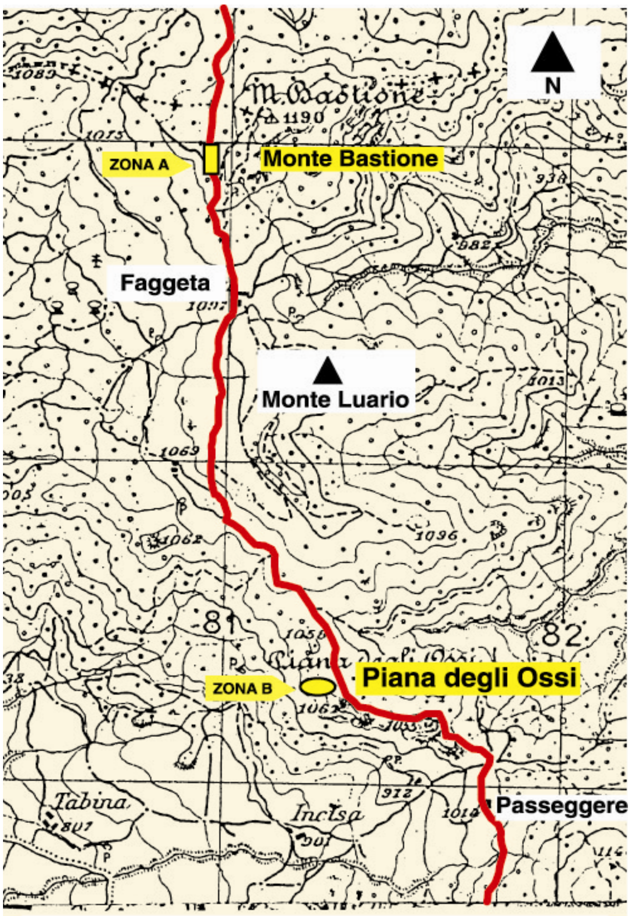


Plate 17
Roman route.
Archaeological site B: the kilns found in Piana degli Ossi.
(Italian Military Geographic Institution (I.G.M.) authorisation No. 5034 dated 13.07.99)

These characteristics revealed that this was under-fired limestone. Now that we were able to carefully observe the particular ground conformation from another point of view, we realised we were looking at a series of six limekilns (five had collapsed), located near the same number of pits. The structural features of one appeared to be almost intact, considering there was a circular depression in the ground that highlighted the perimeter of the upper part of the kiln. A small excavation brought to light a number of sandstones vitrified by heat and which were part of the kiln casing.

The six limekilns at “Piana degli Ossi”, must have fallen into disuse a very long time ago; in times so remote that all memory of them has been forgotten and even the place name does not refer to this industry.

Therefore, it was important to verify when the installation was built, or at least when it was last used. To do this we had to find carbon residues from the firebox in the limekiln. The thought of reaching the firebox of the partially collapsed kiln overwhelmed us. From our view above ground, we estimated that the kilns must be buried below at least 3-4 metres of soil.

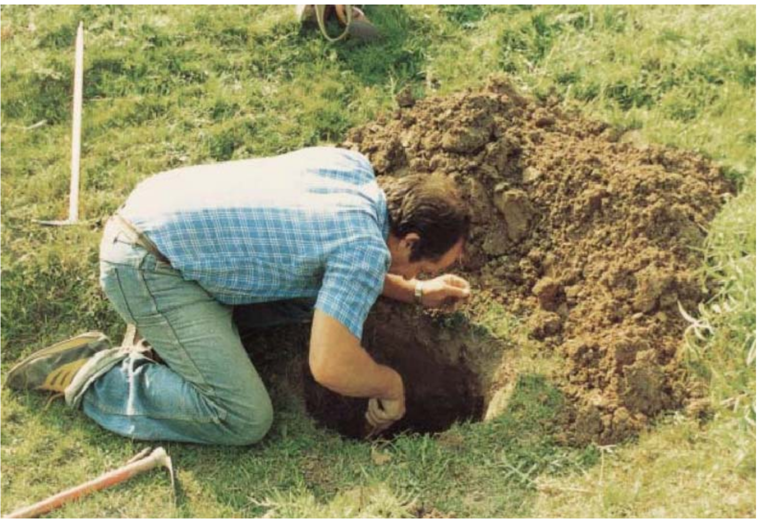
In August 1981, we manually bored a few cores in the lowest part of one of the five kilns we believed had collapsed. After a number of attempts, we found at a depth of 80-90 cm, consistent amounts of carbon which could have been produced by the kiln fires.

Piana degli Ossi (July 1981): *after an initial test excavation on Piana degli Ossi, we uncovered a number of sandstones reddened by the heat, confirming the existence of kiln walls.*

We contacted the University of Florence, and the carbon samples were analysed thanks to Carlo Azzi during the first months of 1982 in the C.14 laboratory of the C.N.R. [National Research Council] in Florence. The carbon was dated back to 330 A.D. (give or take 30 years)[1].

This date was interesting in terms of providing an overall evaluation of the finds and could help

[1] Certification of this analysis was issued by Carlo Azzi in 1984, after he had been transferred to the Institute of Physics at the University of Rome (document 4).



Piana degli Ossi (August 1981): *a core is bored manually during the search for carbon from the firebox of a collapsed ancient kiln: Franco Santi starts the excavation*.

Piana degli Ossi (August 1981): *Cesare Agostini shows the carbon residues found at a depth of 80-90 cm.*

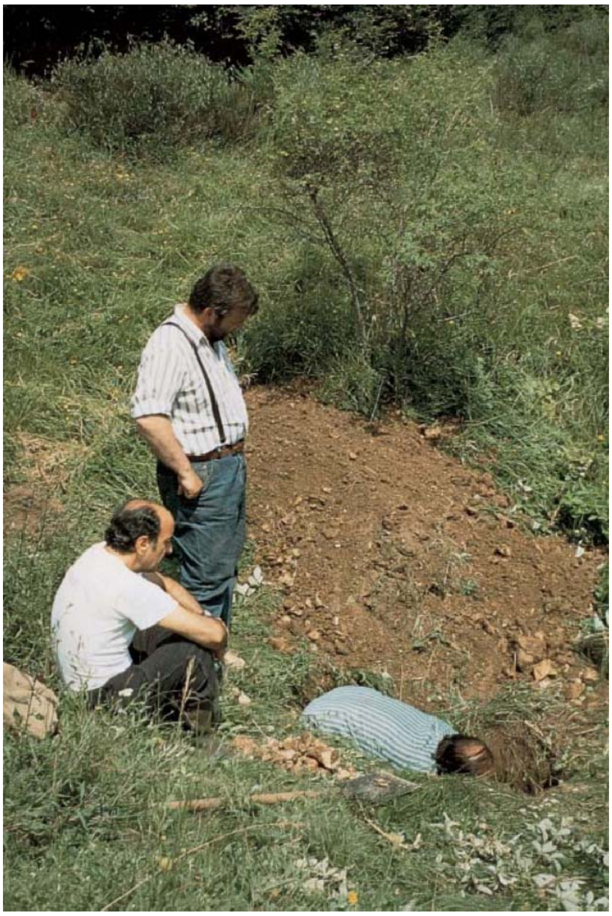
our quest. Because we had been unable to explore the remains, we were not certain that the samples came from the firebox of the collapsed kiln, although they had certainly been taken from the bottom of the presumed collapsed kiln, positioned in the lowest point of the hollow on Piana degli Ossi. We chose to look here for carbon material because we thought that when the kiln was used to fire limestone, the firebox must have been cleaned repeatedly. Although the combustion waste was then removed to a dump, some carbon residues must have remained on site, and the ones we found must have been the remains of the last fires that were lit. This consideration allowed us to evaluate 330 A.D. as an "ante quem" term, in the sense that if the last limestone firing cycles in the collapsed kiln were from the late Imperial age, the kiln must have been built before then.

This opinion was also backed up by the size of the installation compared to the isolation of the location where it was built.

As time passed, we felt the initial dating needed to be verified and the bottom of the partially collapsed kiln needed to be excavated so that we could compare our theories. We had to wait another seven years before we could take another sample, because we wanted the process to be witnessed by the authoritative presence of Luca Fedeli, Chief Inspector of the Archaeological Superintendency for Tuscany who, only as late as 1986, was entrusted to supervise our explorations and safeguard any finds. This occurred in July 1988, in the presence of Agostino Salomoni from the ENEA research centre in Bologna, who offered to make the necessary datings, and also thanks to the kind efforts of Giuseppe Longo from the Department of Physics of the University of Bologna.

The sample was again taken from the lower central area of Piana degli Ossi, but this time near the first, only partially collapsed kiln, beyond its presumed base and at a depth of 1.90 metres. The dating carried out by Salomoni in laboratory C.14 of ENEA in Bologna was as follows: 700 years A.D. (give or take 300 years)[2].

[2] The certification issued by Agostino Salomoni from ENEA is enclosed herein (document 5: sample Bo-108). It also indicates datings regarding other samples taken during 1988 in nearby areas, referred to below.



Piana degli Ossi (July 1988): *taking samples of carbon material at the foot of the first kiln. Franco Santi excavates under the watchful eye of Luca Fedeli from the Superintendency (standing) and Agostino Salomoni from laboratory C.14 from ENEA in Bologna (sitting).*

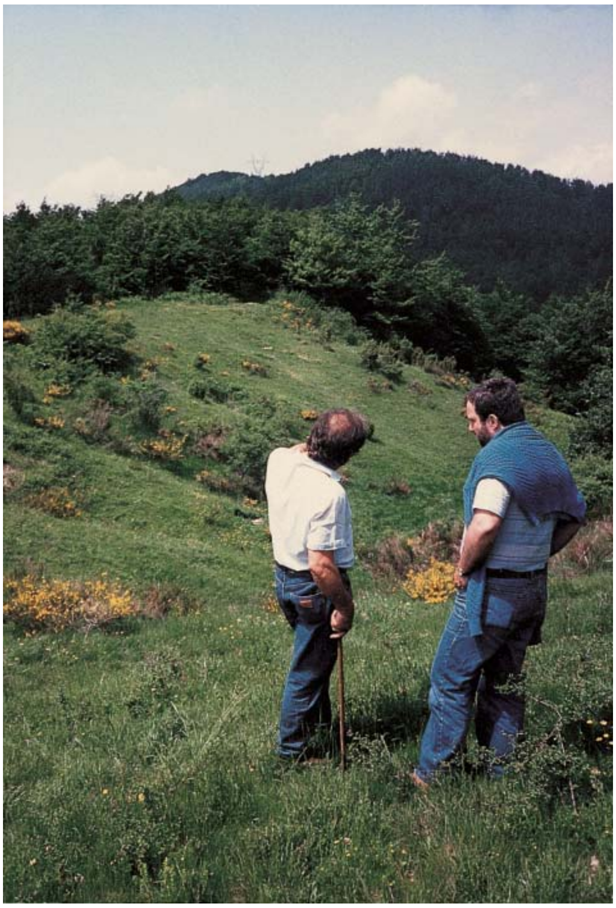
Although the time span was greater, this confirmed that the installation was probably used between 400 and 1000 A.D.

In our opinion, the carbon residues analysed should be attributed to prolonged re-use of the first kiln compared to the other five collapsed kilns. This kiln may have been re-used because its structure was better preserved, or more probably, it was rebuilt on the same site because it was nearer the road and therefore more convenient than the others.

At this point, it was important to unearth the entire complex, carrying out a dig under the direct surveillance of the Superintendency for Tuscany with a large workforce. Thanks to the efforts of Luca Fedeli and the concrete collaboration of the Municipalities of S. Benedetto Val di Sambro and Firenzuola, who received the necessary funds from Soc. Autostrade in Rome, it took one year to carry out all the preliminary procedures.

2 - The excavations carried out by the Archaeological Superintendency for Tuscany.

On 17 July 1989, the excavation was started by members of the Archaeological Cooperative of Florence, under the direction of Luca Fedeli, and with the help of the workers from the Tuscany-Romagna Forestry Cooperative of Firenzuola. The first excavation started in the point we indicated, and where it was believed the kiln walls were well-preserved (kiln 1). Given the predicted scale of the excavation, a mechanical excavator was used to remove the first layer of soil.



Piana degli Ossi (July 1989): *Franco Santi shows Luca Fedeli the exact spot to excavate to uncover the still intact kiln.*

Piana degli Ossi (July 1989): *Franco Santi, Luca Fedeli and Cesare Agostini preside over the initial outlining of the excavation area.*

Piana degli Ossi (July 1989): *the excavator removes the topsoil. In the background, mount Luario overlooks Piana degli Ossi.*

Piana degli Ossi (July 1989): *panorama of the excavation area. In the foreground, the top stones of the kiln being uncovered.*

Piana degli Ossi (July 1989): *after a few days of excavation, the circular sandstone walls on the upper part of the kiln can clearly be seen. Note the reddish colour of the inside wall due to the intense heat developed when firing the limestone.*

Piana degli Ossi (July 1989): *as the excavation proceeds, the archway of the lower kiln stoking hole and a first layer of quicklime are unearthed.*

Piana degli Ossi (July 1989): *Luca Fedeli (second left), A. Salomoni, Marco Antonelli and Emanuele Stefanini on the edge of the almost entirely exposed kiln* .

The area due to be manually excavated during this initial phase (the highest part of the presumed kiln) was then cordoned off with coloured tape. At a depth of about 50 cm, the first row of sandstone blocks appeared. They were laid in a circle and were rosy in colour due to the heat. Many pieces of limestone destined to be fired were found inside the perimeter walls; the colour of the limestone nearer the surface was natural but as the excavation deepened, the limestone closer to the heat source became increasingly pink. When we reached a depth of about 1.5 metres, we thought we had reached the bottom of the kiln because we found a beaten clay surface with numerous carbon residues. This turned out to belong to a more recent phase of the kiln; we reached its original base after the excavation was deepened some two metres further[3].

At the end of the excavation, it was possible to comprehend the chronology with which the kiln had been used (it contained a large amount of quicklime and conspicuous remains of fire). The perimeter wall was about four metres high (perhaps it was originally five metres high to match

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[3] Luca Fedeli published a detailed report of the results of this excavation in the "Atti del Convegno sulla viabilità tra Bologna e Firenze nel tempo" (page 59 and following pages) to which we refer. As regards these first stages of the excavation of the kiln (conventionally named "site A") he expressed the following (page 59):

"site "A" effectively brought to light the remains of a limekiln used during two different phases… (omissis). *The more recent use of the kiln appears to be a reconstruction "in situ" of the building structures above the occluded former phase. The new kiln featured a high opening, located above the opening of the former kiln, but facing in the same direction and almost parallel (as well as almost directly above)".*

Piana degli Ossi (July 1989): *an image of the entire kiln. On the left is the stoking hole to the firebox. There are still the candid remains of quicklime on the rear of the right wall.*

the higher part of the installation). The carbon material found in the firebox of the lower kiln area (referable to its last use) dates back to the year 1370 A. D. (give or take 60 years)[4]. Whereas the carbon remains found in the upper level of the kiln (referable to its last use) date back to 1410 A.D. (give or take 50 years)[5].

Furthermore, Fedeli says about this kiln[6]: "*a sample of carbon material removed by myself on 10 July 1988 from the upper layers of the kiln, excavated a year later on site "A", was analysed by Department T.I.B. of E.N.E.A. in Bologna, thanks to the kind efforts of A. Salomoni.* (ceteris omissis). *The material dates back to 700 A.D. (give or take 300 years).*"

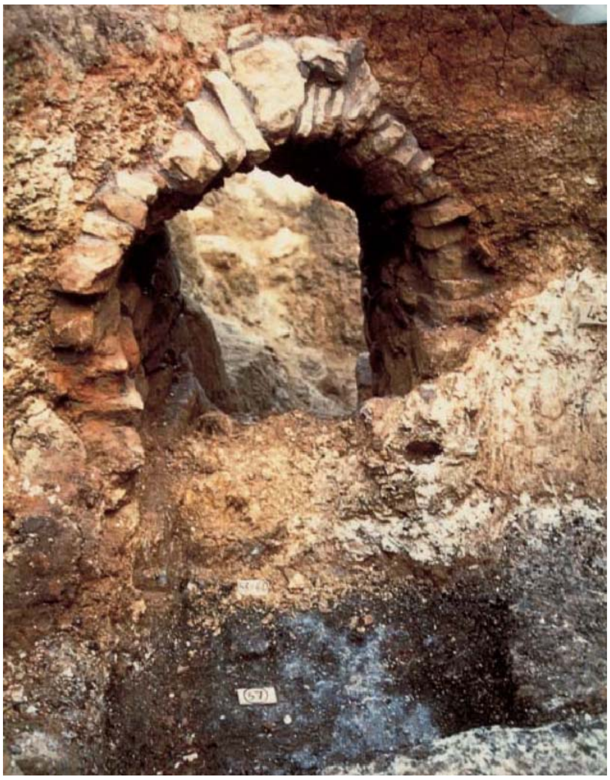
Thermoluminescent analysis of a fragment of the kiln wall, which dates the wall back to the year 882 A.D. (give or take 94 years), confirmed this dating[7].

Therefore, if a sandstone block from the kiln wall was subjected to high temperatures during the 8th-10th centuries, this means that the kiln was built or rebuilt during the same period (or earlier) and it was only re-used at sometime during 1350/1400 A.D., as proved by the dating of the carbon found in the firebox.

To ascertain the existence of the other collapsed kilns, the Superintendency carried out an excavation named "site B" at the base of the sixth presumed kiln in the southernmost part of Piana degli Ossi. The remains of walls and other quicklime residues emerged, proving that in antiquity there was also

[4] Luca Fedeli: work cited, note 18, page 88.
[5] Luca Fedeli: work cited, note 20, page 88.
[6] Luca Fedeli: work cited, note 13, page 87.
[7] This analysis was carried out on request of the Archaeological Superintendency for Tuscany by the Department of Physics of the University of Milan on 05/09/1990 (document 6).

Piana degli Ossi (July 1989): *the external side of the firebox stoking hole, located at the bottom of the kiln, where wood was introduced to feed the fire.*



a firebox on this site too [8].

Finally, the lowest-lying area in the centre of Piana degli Ossi (called "site C") was excavated to verify if it featured some sort of rainwater drainage system. This was because water never collects here and water plants do not grow in this area although it is shaped like the bottom of a bowl. The excavation drew a blank, perhaps because it was not deep enough [9]. Nevertheless, the excavation did provide limestone and carbon remains which date back to the year 615 A.D. (give or take 55 years), as mentioned by Fedeli in note 30 on page 88

Piana degli Ossi (July 1989): *the inside base of the kiln. Note the carbon residues in the firebox and, on the right, a large quantity of quicklime which has remained on the bottom. The inside of the stoking hole can clearly be seen. The firebox used to fire the limestone was fed through the stoking hole.*

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[8] Luca Fedeli: work cited, pages 64-65: "*Site "B" highlighted the existence of two distinct archaeological phases; the first should presumably be considered peripheral because it refers to a kiln located in an unexplored area, located further uphill* (ceteris omissis); *the second refers to the re-use of the excavated site. This re-use must have taken place later than the use of the kiln further uphill mentioned above*".
In note 24 on page 88, Fedeli concludes: "*this kiln has not been identified or investigated but its remote existence is clearly revealed by a number of clues"*.

[9] Why rainwater is absorbed rapidly and completely remains a mystery. As mentioned, although the area is shaped like the bottom of a bowl, water never collects here (unlike in every other neighbouring area where water collects even if there is just a slight depression).

Piana degli Ossi (July 1989): *view of site "B" which highlighted the collapsed remains of the sixth kiln located in the southernmost part of Piana degli Ossi.*

of his report [10].

Fedeli draws very cautious conclusions about this campaign of excavations in terms of the time span within which the kilns were used, and even more so in terms of when they were first built[11]. Nevertheless, even if Fedeli predicts that these kilns date back to late antiquity (6^{th}-7^{th} centuries A.D.) our opinion goes further: perhaps the first installation on this site dates back to even earlier. It is true that no archaeological remains have been found to prove this but it is also true that the excavations carried out were very brief (from 17 July to 10 August 1989) and limited; perhaps a complete excavation of Piana degli Ossi would have revealed older remains that may have allowed a more precise reconstruction of the history of the area along a longer timeline. Nevertheless, we had reached some of the objectives that the Archaeological Superintendency for Tuscany and ourselves had aimed to achieve:

- we wanted to know if there was a well-preserved kiln and such a kiln was unearthed;
- we wanted to know if there were any remains on the southernmost site of Piana degli Ossi which may point to one of the collapsed kilns, and these remains were found.

The campaign of excavations confirmed the existence of an ancient installation of six limekilns, as we had guessed by simply observing the ground surface and as illustrated in a drawing published in our first book (before these excavations started)[12].

3 - The six kilns: an impressive industrial installation.

Before we leave Piana degli Ossi and these important finds, we would like to offer some thoughts that accompanied us while the existence of the six limekilns was confirmed. We did more than just make note of the remains uncovered or the results of the analyses; we attempted to project our minds back to antiquity when the installation was built and, especially, when the six kilns were used simultaneously. We wanted to understand the various production phases

[10] Luca Fedeli: work cited, page 66: "*Instead site "C" on Piana degli Ossi, carried out from 20 to 27 July 1989, excluded – at least in terms of the limited but significant excavation area – the existence of any structured drainage systems in the valley bottom of the saddle; however it did reveal (at a considerable depth) a series of layers of waste (limestone and carbon), which archaeometry locates in a later age than those found elsewhere on Piana*".

[11] Luca Fedeli: work cited, page 72: "*however, some of the archaeometric data would suggest that Piana was being used (perhaps for reasons linked to similar later human activities) during the Upper Middle Ages or perhaps even during late Antiquity*".

[12] C. Agostini - V. Di Cesare - F. Santi: "La strada Flaminia Militare" published by Studio Costa, 1989, page 40.

An ideal reconstruction of the kilns on Piana degli Ossi drawn before the excavations in July 1989 and published on page 40 of our book "La Strada Flaminia Militare". *The morphology of the area, the not completely fired limestone and the two carbon sample datings gave us an idea of their probable original structure (later confirmed by the excavations). The installation is similar to Etruscan installations found on Elba* (drawing by Stefano Borelli).

required to make limestone and the work organisation needed to run an industrial installation of this type.

Not anyone, even the attentive observer, will note any great difference between this area and other neighbouring areas. It is now a meadow covered by brambles and broom bushes, shaped like an elliptical amphitheatre along a north-south axis; its eastern side starts from the adjacent road and, with a slight upwards slope, it continues around the upper edge towards the west until it is six metres above the level of the Roman road. Here the escarpment features parallel hollows alternated by spurs which leave no doubt that they are manmade. The hollows are none other than collapsed kilns used to produce quicklime.

On first consideration they seem nothing special; limekilns can be found almost everywhere on our Apennines. Numerous locations are named after limekilns, such as: Forno, Calcinaia, Fornace, Campo del Forno, etc. Other kilns were mentioned by elders, or it is possible to make out burnt stones and limestone remains, obvious clues revealing that at least once upon a time, limestone was fired in the area. However, it must be underlined that, when researching the limekilns on our Apennines, we never found any trace (either on the ground or according to local tradition) of two kilns functioning at the same time in the same place. Therefore, six kilns located near to each other is a unique occurrence and deserves in-depth analysis.

It is important to note that the kilns on Piana degli Ossi and the other individual kilns built throughout the Apennines to provide a cement bonding agent for the scant construction work were periodical kilns.

In periodical limekilns, every batch had to accomplish a complete cycle, so efficiency in terms of fuel and time was very low compared to more modern perpetual kilns, which are continuously fired by coal. Just consider that all the lime had to be unloaded through the top of the kiln and only after

the entire production batch had cooled down.

To understand better the turnaround of these six kilns, it is necessary to observe how each kiln was built and how they functioned.

3.1 - The choice of location for the kilns and the construction technique.

The limekilns had to be built in the right location, which complied with the following requirements:

- they had to be protected from prevailing winds. A good location was on the side of a ridge top, where the wind blowing from the opposite side would be forced upwards to overcome the obstacle. This created an undertow, which encouraged combustion of the wood in the firebox and lifted smoke and gases upwards;
- they had to be built at the foot of a slope and recessed within the slope. This had numerous advantages: it provided two practical access points, one above for loading and unloading, as well as a large area where the limestone could be stockpiled, and one below for the firebox, which needed a large clearing where the firewood could be stored. The firewood was kept at a due distance from the kilns to ensure the gangs feeding the firebox with the bundles of firewood and removing the ashes had plenty of room for manoeuvre.

If the kiln could be recessed within clay-like earth, this provided a solid casing and excellent thermal insulation. Once the fire was lit, it had to be fed continuously. Therefore, the stokers had a very tough job, feeding the fire day and night, whatever the weather. Even a half-hour break would have compromised many hours' work to recover the lost calories.

It was best to locate the kiln as near as possible to the raw materials (the limestone quarries and the trees needed to provide the firewood).

The distance from the place where the lime was needed also had its importance, because the same volume of quicklime produced weighed just over half the "raw" limestone.

Once the most suitable site had been identified, a cylinder was then excavated. The diameter of the excavated cylinder was about 80 cm larger than the diameter of the kiln to allow space for the exterior wall of the kiln. The exterior wall was made of sandstone, which crumbles easily in freezing temperatures but also has excellent heat resistant properties.

Construction of the kiln wall did not require any particular skill; the blocks just had to be close fitting and even, and the inside surface had to be aligned with the circumference so that it formed the inner kiln wall. Clay was packed against the outside wall because it would be hardened by the heat of the kiln and thus provide the entire structure with great solidity and offer excellent insulation.

A well-built limekiln had to be shaped like two opposing truncated cones. The lower cone was upside-down (that is with the base facing upwards), and it had to be half as short as the upper cone. The stoking arch was built on ground level[13], where the

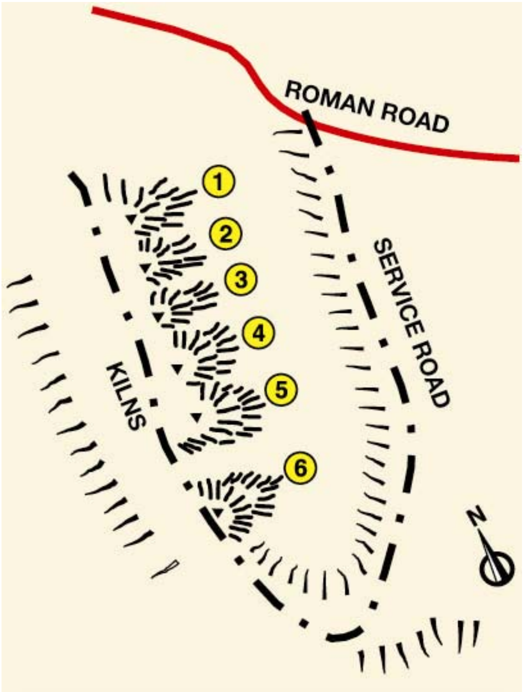


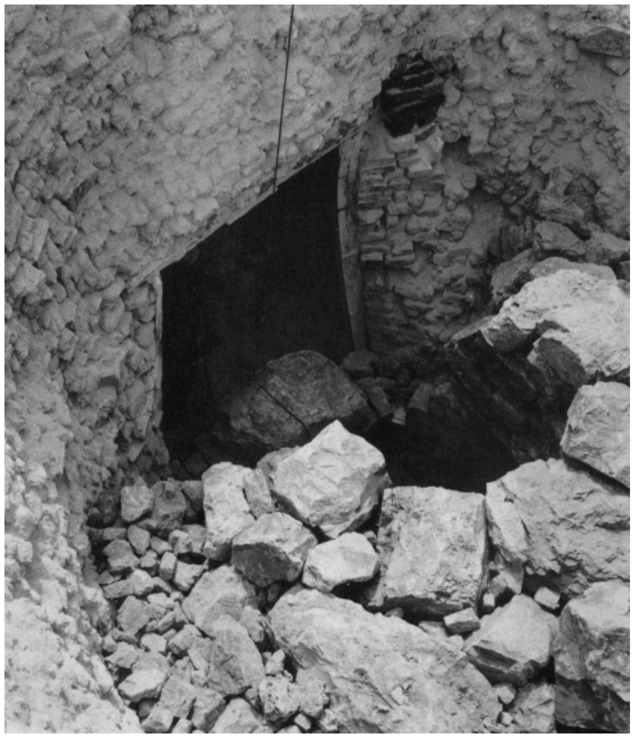
Plate 18
Planimetric outline of Piana degli Ossi with the position of the six kilns.
(Survey and drawing by Vittorio Di Cesare).

[13] In the kiln unearthed in 1989, on either side of the lower part of the firebox stoking arch, there are two stone protuberances measuring about 4 cm, which supported and guided the moving shelf used to push the firewood inside.

wood was burned (firebox). The kiln was loaded by piling the limestone inside it; an empty volume was left so that it formed a vault (the firing chamber). This was connected to the outside by the stoking arch (shaped like the span of a bridge to allow the firewood to be introduced). The pieces of limestone were arranged carefully so that there were gaps to allow the passage of hot gases, but also so that the weight above would be supported. If the limestone collapsed during firing, this would have spoilt all the work carried out beyond repair.

Arranging the limestone inside the kiln was a skilled job; it was necessary to ensure that the heat produced by the firebox was distributed as evenly as possible to avoid areas of insufficiently fired lime. If the lime was under-fired, the centre of some stones remained "raw" (these "raw" centres are shaped like bones and can very easily be mistaken for bones).

Finally, the dimension of the limestone pieces was also important; they had to be as evenly sized as possible, which was difficult due to the crumbly nature of limestone. Nevertheless, the larger pieces were placed near the bottom and the smaller pieces near the top where they required less firing time.



A kiln in Campania: when the kiln was loaded, the largest blocks of limestone were used to create the firing chamber (from *Jean Pierre Adam: "L'arte di costruire presso i Romani - materiale e tecniche"* published by Longanesi e C., Milan, 1984).

3.2 - The processing units used and the amount of lime produced.

Taking the kiln unearthed in July 1989 (and still partially visible) as an example, it is possible to attempt a calculation of the work force required to run the entire Piana degli Ossi installation and the amount of quicklime it could have produce by reconstructing the various production phases.

The production cycle of a kiln ranged from 18 to 20 days. The work procedures that needed to be accomplished were: repair of any heat damage to the walls while the kiln was being fired, loading the limestone, firing, cooling and unloading the lime. The lime then had to either be stored somewhere where it was protected from the rain or it had to be sent to the building sites where it was needed. Therefore, a kiln had to be fired every three or four days and the first kiln had to be relit after some three weeks.

When the first kiln was loaded with limestone, a large amount of thinly cut firewood was burned to start the firing process.

Completion of a loaded kiln near Epidaurus in Greece. The same procedure has been handed down through the centuries and the similarity with the fully loaded kiln uncovered on Piana degli Ossi is striking. (From Jean Pierre Adam: "*L'arte di costruire presso i Romani - materiale e tecniche*" published by Longanesi e C., Milan, 1984).

Firing continued for as long as 5-6 days, so that a temperature of 800-900 degrees was reached, necessary to convert the lime (calcium carbonate) into quicklime (calcium oxide).

Each kiln had an actual capacity of some 20-22 cubic metres[14], producing more or less 250 tons of quicklime[15]. Therefore, every production cycle of the entire six-kiln installation produced about 1500 tons every 18-20 days. Obviously, more or less the same volume of limestone was quarried by a work force which we estimate in default of about 8-10 workers, bearing in mind that layers of limestone can vary in thickness from tens of centimetres to a few metres[16] and are hard to find in open-cast mines. Therefore, it would have been necessary to remove any material above such as friable loam rock (in the best cases) or even compact layers of sandstone. Added to these difficulties were the inefficient tools of the age.

Once the limestone was amassed at the foot of the quarry, it had to be transported to the upper part of the kiln by pack animals. Packsaddles featured two boxes, one on the left and one on the right. The bottom of either box was hinged on the inside and tied to an external strap. Thus, by pulling the end of the rope, the boxes opened and were emptied simultaneously without unbalancing the load[17]. The material was loaded into the boxes piece by piece and positioned with care to ensure the same weight was distributed on both sides. This avoided unbalancing both the packsaddle and the pack animal, which otherwise would have found it difficult to advance.

Although the kilns were fired in all weather conditions, work in the quarries was impossible when it rained or snowed. Therefore, it was necessary to ensure there was a large amount of reserve limestone, which was extracted in excess on good days and stored in the area above the kilns. We estimate that no less than twenty workers and a large number of pack animals were employed to extract and transport the limestone.

At least another twenty workers were needed to run the six kilns. Estimating that two kilns had to be kept constantly alight by workers working in eight hour shifts per day, if two people were employed per shift per kiln, twelve people were needed to run the kilns for 24 hours, plus eight other workers (only employed during the day) needed to load and unload the other four kilns.

The supply of firewood must be added to these two production phases. Between woodcutters and “carriers”, we estimate that no less than ten people were required. The same applies to this task as for the limestone above: a large amount of reserve wood was needed for rainy days as well as someone to carry out surveillance: at least a foreman and another four or five guards to cover 24 hours.

Furthermore, there were the catering and accommodation needs: considering these were all very heavy jobs, there must have been a good kitchen and accommodation where it was possible to have a good rest; no one would have survived without adequate treatment. Therefore, every day, Piana degli Ossi had to be supplied with a huge quantity of provisions and water. It is difficult to determine the number of people employed to carry out this auxiliary work, but it must have been no less than eight to ten people.

Therefore, about 65/70 people had to be employed to run the installation and the six kilns. Added to these were the carriers employed to convey the quicklime to the construction sites where it was needed. Were these building sites far off?

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[14] Considering that the average diameter of the kilns was 2.50 metres and the minimum height was 4 metres, this provides a theoretic volume of about 31 cubic metres. Bearing in mind that the limestone was arranged with care, leaving small gaps between pieces to allow the passage of heat and smoke, the actual volume of the limestone can be considered less than a third of the total volume and, therefore, about 21 cubic metres.

[15] The specific weight of impure limestone is more or less 26 tons per cubic metre. Supposing that 80% is pure calcium carbonate (the other 20% consisting in waste: clay, silicates, etc.) there are only about 21 tons available to convert into quicklime. The conversion process determines a 44% weight loss (carbon dioxide) therefore providing 56% of quicklime (calcium oxide), which corresponds to (for every cubic metre of limestone used) a production of about 12 tons of quicklime, without considering the weight of the waste. Therefore, every kiln firing cycle produced 252 tons of quicklime (21 cubic metres x 12 tons = 252 tons).

[16] In the area around Piana degli Ossi, we did not find any remains of limestone quarries; they may have run out.

[17] This system continued to be used in our area of the Apennines until the mid 1900s.

They certainly were, considering there are no remains of grandiose buildings that presume the use of so much construction material. It is difficult to define how many people and animals were employed to transport the goods; certainly no less than fifteen to twenty people, bearing in mind that 80 tons of lime must have been dispatched every day[18].

3.3 - Does the construction era of the six kilns date back to the second century B.C.?

In conclusion, about ninety people and a large number of pack animals must have been employed to run this industrial installation. We believe this is a fair estimate of what happened on Piana degli Ossi during those remote times.

However, many mysteries remain which will perhaps never be cleared up: who designed, calculated and constructed this large six-kiln installation? Who had enough resources to employ so many people? Where was the destination of the huge amount of lime produced?

It is difficult to answer to these questions with any certainty.

The existence of six kilns in the same place demonstrates that they were built to function simultaneously in a cycle to meet a large demand for lime. If a lower production volume had been required, only one or two kilns would have been built, as occurred in the Middle Ages on Piana degli Ossi. In fact, the excavations uncovered a single kiln (still almost entirely intact), which was evidently rebuilt during the Middle Ages to cope with a modest demand for lime.

If our ancestors who lived in the valleys of the Savena and the Setta, had handed down to posterity tales of how they had seen the kilns on the ridge north of Passeggere, they also would have told of the long columns of carts or pack animals walking along the ridge (southwards or northwards) to reach some important city, because only large-scale constructions such as bridges, city walls or buildings could have required such a huge amount of lime.

Nevertheless, no memory of this has been handed down by our ancestors. The place has reached us with an inaccurate name (Piana degli Ossi) [Field of Bones] confirming that the kilns are so old that all memory of them has been lost. Therefore, the idea that such an installation was built by the Romans not long after the transapennine road, in a moment in history when there was a very big demand for lime[19] appears reasonable (considering the probable enthusiasm to build north and south of the Apennine range after peace was finally established and Roman dominion was consolidated).

It is also worth pointing out that although the ancients were aware of the properties of lime, its general use as a bonding agent for building materials was introduced by the Romans[20]. Therefore, it is reasonable to believe that they alone could have needed such a large daily production of lime requiring an industrial installation with six kilns.

Comparison with limekilns used in various Mediterranean countries (Italy, Greece, Tunisia, Syria, etc.), where the process has remained basically unchanged since antiquity, has allowed us to describe with a certain reliability the kiln construction techniques and production processes used by the Romans.

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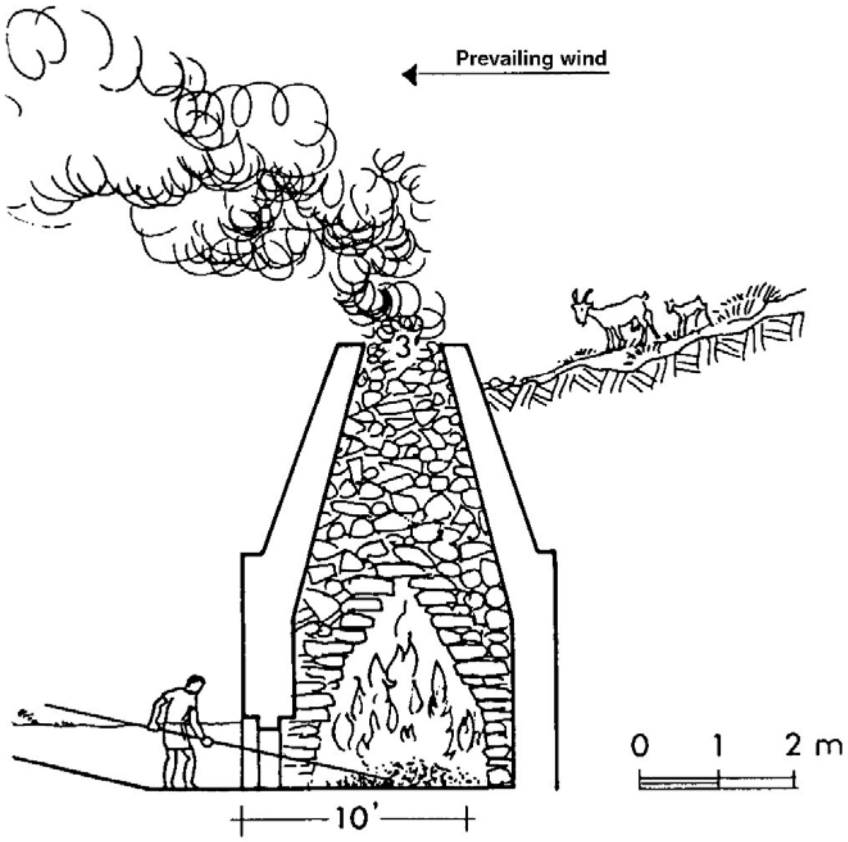
[18] These calculations refer to such a remote time that they have been carried out by default, bearing in mind the dimensions of the discovered kilns still full of almost fired material. Why was this kiln prepared, fired and then abandoned just one day before the production cycle was due to be completed? We believe it was due to cruel events. Perhaps the incursions by the Company of Count Lando mentioned in Chapters V and VI?

[19] Jean-Pierre Adam: "L'arte di costruire presso i Romani - materiale e tecniche". Longanesi e C., Milan, 1984). The historian, Adam, mentions the "De agri cultura" treatise by M. Porcius Cato with these words (page 734): (Omissis) "*Cato, who wrote in about 160 B.C., in the precise moment when masonry constructions bonded with lime mortar began to be widely used…*" (Omissis). Therefore, this period of time corresponds to a few decades after the transapennine road was built.

[20] Jean-Pierre Adam: work cited, page 69: "*It must be said that although the Greeks were aware of lime, they used it mainly to prepare plaster, painted plaster and to cover water tanks. The Roman's fundamental contribution consisted in the systematic use of lime (instead of clay) to prepare mortar used as a bonding agent for stone masonry and thus achieving a permanent bond that allowed the use of concrete in larger buildings and to construct vaults of extraordinary size*".

Our reconstruction also matches the description by M. Porcius Cato in his treatise, “De agri cultura”[21]: “*the limekiln must be 10 feet wide and 20 feet high; reduce the width to 3 feet at the top. If you only use one stoking hole, ensure there is a large cavity inside, large enough to hold the ash, so there is no need to pull it out; ensure that the hearth entirely occupies the bottom surface of the kiln* (omissis). *Ensure that the fire never goes out, not even during the night or at any other time. Load the kiln with good quality stones, the whitest and least stained as possible. When you construct the kiln, provide the pit with a steep slope; when you have dug down enough, arrange the firebox so that it is as deep as possible and as least exposed to the wind as possible; if there is not a suitable place for building a deep kiln, construct the upper part out of brick or stone using mortar and cover the exterior. When the fire is lit, if you see that the flames exit elsewhere other than the circular aperture at the top, close any holes with mortar. Do not allow the wind to enter through the hole, especially the south wind. This is how you will know that the lime is fired: the top stones must be fired, then the lower stones (also fired) will yield and the flame will produce less smoke”.*



Reconstruction of the kiln described by M. Porcius Cato in the treatise: “De agri cultura” XLIV, “De Fornace calcarea” (taken from jean Pierre Adam: “L’arte di costruire presso i Romani - materiale e tecniche”. published by Longanesi e C., Milan, 1984).

[21] M. Porcius Cato: “De agri cultura” XLIV, “De fornace calcarea”.
Cato, called the Censor, was born in 234 B.C. in Tusculum (an ancient Latin city near the present-day Frascati) from a family of landowners. He soon moved to Rome where he had a successful public career. He lived through the entire period of the second Punic war and the war against the Ligurians. He wrote most of literary works in his old age: his “De agri cultura”, which has been handed down to us in its entirety was probably written in 160 B.C.

4 - Mount Luario

In this area of the ridge, the place name of a small hill called mount Luario aroused our curiosity, located about one hundred metres further north.

Its summit stands at 1140 metres above sea level and overlooks the Piana degli Ossi (1062 metres above sea level). There is not much difference in height between the two, but because they are close to each other, one has the impression that mount Luario dominates Piana degli Ossi. This sensation gave us the idea that the place name may originate from the name of the pagan goddess, Lua, the goddess of propitiation, in whose honour the Romans usually burnt the arms and corpses of defeated enemies[22]. The place name could be linked to theoretical pyres lit on the top of the hill, or to atone slaves or convicts condemned to carry out forced labour, probably obliged to run the kilns on Piana degli Ossi below. The men entrusted to fire the limestone had to carry out strenuous work to extract and transport the limestone, and to cut and transport the firewood. Furthermore, filling and emptying the kilns involved handling ashes and quicklime which, in such as well-ventilated place, could easily come into contact with the eyes, causing irreparable damage.

The proximity of these places is undoubtedly suggestive and both call to mind names and situations which probably date back to the Roman age. And so driven by the curiosity that has often guided our explorations, we excavated the centre of a small upland plateau, covered in ferns, almost at the top of mount Luario; at a depth of two metres, all we found was a consistent layer of ash and carbon residues.

The Archaeological Superintendency for Tuscany also made a test excavation in the same place during the campaign on Piana degli Ossi. They confirmed the existence at a certain depth of a large amount of carbon residues, but nothing more[23].

In conclusion, no traces of burnt arms or corpses were found on top of mount Luario; perhaps there was only the idyllic presence of the goddess Lua, who watched over those who endured their punishment on Piana degli Ossi, inducing them not to attempt an escape. This may be pure invention, but the theory whereby this place name may originate from the goddess Lua is also backed up by the fact that other hills along this itinerary are named after pagan divinities such as Venus and Adonis.

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[22] T. Livius: work cited, book VIII, paragraph 1
T. Livius: work cited, book XLV, paragraph 33: "... *when the bronze shields were loaded on board the ships, the consul* (Paulus Aemilius) *collected all the other arms of every type and made a huge heap. After invoking Mars, Minerva and Lua Mater and all the other gods to whom the spoils of the enemy must be solemnly dedicated, he then applied a torch underneath the heap and set fire to it. Then each of the military tribunes all around threw a brand on the heap*".
Lua Mater and *Lua Saturni* (because often next to Saturn) was the name of an ancient Roman deity who presided over propitiatory sacrifices and purifications and who was later identified with *Nemesis,* the goddess of divine retribution, she was apparently the daughter of Jupiter and she persecuted the evil and those who did not know how to make good use of the gifts given to them by providence. She gave no peace to whoever had in some way upset the natural and social order of life. In Greece, and especially in Attica, she was the object of a special cult, later embraced by Rome, where a statue of her was installed on the Campidoglio. In one of his poems, Catullus describes her as violent and inexorable. This divinity is also mentioned by Marcus Terentius Varro *(De lingua latina, VIII, 36): "... therefore many words which are formed by declining different words are the same when I use the accusative "luam" from "Lua of Saturn" and from "luo = solve" I form the future "luam"*.
Varro's quotation reminds us of some of the meanings attributed to the verb *luere*: undergo a punishment (*mei peccati luo poenas:* I pay the price of my error, Cic. Acts 3, 9, 1,); expiate (*aliquid voluntaria morte luere:* expiate a wrongdoing by killing oneself, Cic.). Therefore the deity's name itself (regardless of the prerogatives attributed to her by the Romans) calls to mind the concept of expiation.
(Thanks to Vittoria and Franco Bacci for their collaboration in this mythological research).

[23] Luca Fedeli: work cited, page 73. The author concludes his comment to this treatise with these words: "*hopefully it will be possible to widen the investigation to good part of the plateau to find new elements to help our interpretation and, subsequently completely confirm or bring into discussion some of the theories expressed in the past*".

5 - Passeggere.

Just a few hundred metres further south of Piana degli Ossi, where the profile of the ridge descends to an altitude of 1014, a number of buildings bear the name of “Passeggere”.

The buildings consist in a farmhouse with a stable and barn and a manor house, which now stand in the heart of a vast privately owned hunting reservation.

The place name “Passeggere” evidently derives from its location within a saddle and the fact that it is the most practical point of passage for those wanting to cross the ridge from the valley of the Gambellato and from the upper Setta valley to the Savena valley and vice versa.

We have already written widely about this pass and its importance within the context of the Apennine road system in Chapter V. Here we would only like to point out that since antiquity, this location has been a crossroad between the north-south transapennine Roman road and a northeast-southwest transversal mule track used by traffic from and to Castiglione dei Pepoli towards the upper Savena, towards Monghidoro and also the Raticosa pass. Very probably, this mule track was especially used from the 6th century A.D., when the Futa pass became an impassable political-military border between the Lombards (who occupied the Tuscan versant) and the Byzantines (whose dominion included Bologna and penetrated as far as the sources of the river Savena[24]).

The people who lived on Byzantine territory in the upper Apennines probably needed a route that by-passed the Lombard border and which allowed them direct and fast access to Romagna[25] and the capital, Ravenna, across the Passeggere and the Raticosa passes, without having to lengthen their route by passing through Bologna.

In the 1980’s, during our explorations we often came across the old farmer who still lived on the Passeggere pass[26] in the farmhouse on the western versant of the ridge; he told us that the house he lived in was built after a former building on the eastern versant was destroyed by a landslide. Furthermore, he remembered that his ancestors had handed down a story whereby in very remote times the first settlement on the Passeggere pass was built on the western versant, where it stands now, and that too had been destroyed by a landslide.

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[24] The impenetrable Byzantine-Lombard border on the Tuscan-Emilian pass continued to exist for almost two centuries; this situation ensured it was impossible to use the transapennine route and perhaps caused the Roman paving to disappear once and for all under a consistent layer of humus. N. Alfieri came up with the same theory (in reference to the route he theorised), and had the following to say (work cited, page 55): “*The doubt remains that the persistence of the Via Flaminia in Roman times was interrupted during the upper Middle Ages when this sector of the Apennines was a border area and therefore a barrier between the territories held by the Byzantines and the Lombards on opposite versants”*.

When the transit of men and animals resumed along this same ridge, an initial path was traced, followed by a mule track that retraced the Roman route (sometimes right on top of the Roman road).

Daniel Sterpos substantially shares the same opinion (work cited, page 35): *“During the long period when the territory between Bologna and Florence was divided between the Lombards and Byzantines, each armed against the other, it cannot be supposed that the two cities were linked by a well-defined, regular and continuous road, but rather that the roads that departed from either city towards the mountains were used by both sides to reach their positions and to attack the enemy’s positions”*.

[25] At the time, this area of Romagna was called the Flaminia Region. It is interesting to note that a stretch of the road under discussion, between the Raticosa pass and Piancaldoli, on the Map by the Topographical Institute of Vienna (1851) is still called *Fiamminga.* Evidently, this name comes from Flaminia, that is, the region it was heading towards (document 7).

[26] Egisto Cavicchi, now eighty-five years old, who lived and worked on the farm for 60 years, as had his forefathers before him.

CHAPTER XI

MOUNT POGGIACCIO
(ARCHAEOLOGY ZONE "C": sites C/1 - C/2 - C/3 and C/4)

1 - Description of the paving (sites: C/1 - C/2 and C/3)

The story handed down by the forefathers of the farmer who lived in the house on the Passeggere in the 1980's, whereby a landslide had destroyed the building that stood there before may appear insignificant in terms of our research. On the contrary, this story was very useful because it made us observe very carefully the morphology of the entire western versant of the ridge between Passeggere and mount Poggiaccio, where the Roman road must have continued towards the Futa pass.

We noticed that signs of an ancient, extensive and deep landslide remain, covering a width of over one kilometre. The landslide detached from the top of the ridge and slid downhill to the flat cultivated fields above the town of Bruscoli. If this large landslide occurred after the Roman road was built, there was no hope in finding any remains. In spite of this, we carefully explored the west versant of "Le Banditacce" hill, between Passeggere and mount Poggiaccio, but to no avail.

However, we did find traces of the medieval mule track which confirmed the age of the landslide. The Roman itinerary probably followed the same direction, passing under the peak of Banditacce (1302 above sea level) and heading

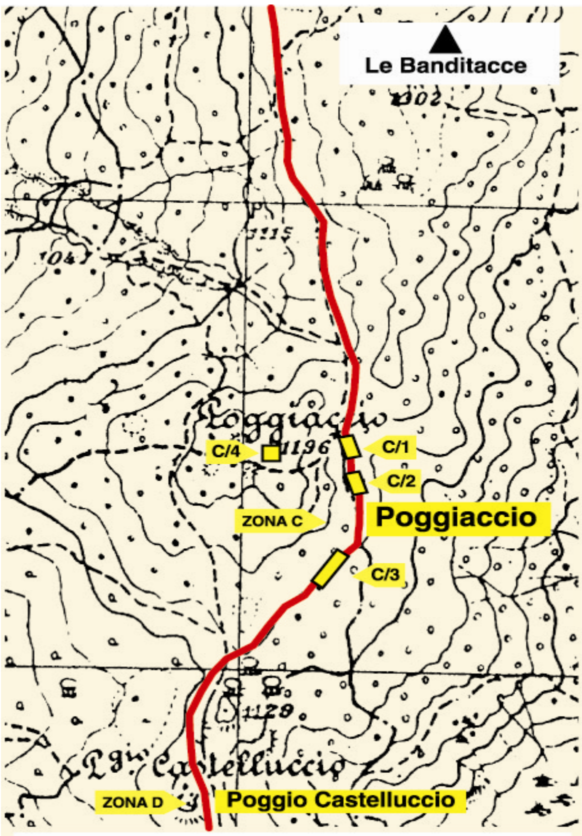

Plate 19
Archaeological site C; finds on mount Poggiaccio.
- Site C/1: paving stones, water collection basin and flat stopping area.
- Sites C/2 and C/3: paving stones.
- Site C/4: hut circle dating back to 2200-1500 B.C.

The route of the Roman road.

(Italian Military Geographic Institution (I.G.M.) authorisation No. 5034 dated 13.07.99)

directly towards the upper slopes of Poggiaccio, with a minimum altitude of 1196 metres. However, Poggiaccio, stands further west compared to the summit of Banditacce, and by following the theoretical straight line of the road, you end up in a small saddle between the two summits, which represents the true orographic pass through the Apennines. In fact, this is where the ascent stops for those coming from Bologna and is where the descent begins on the Tuscan versant.

As always, we placed our trust in the straight-line principle and continued to search on the upper slopes of Poggiaccio in alignment with our point of departure, but on the eastern versant. This decision was taken after contrasting considerations which caused great doubts. We were not convinced that the eastern versant had been the preferred one because it was more likely that it would have been covered in snow during the winter. However, the western versant would have forced a considerable diversion to the right to avoid the peak, thus compromising the brevity of the route.

During our discussions, we opted for the second theory due to two circumstances:

- the existence of a beaten track, now a bridle path, which followed the west versant to reach the Futa pass;
- the impenetrability of the woodland on the eastern versant, due to the vigorous and untidy growth of bushes and ferns.

Therefore, we decided to prefer the straight-line principle, penetrating in the woodland on the eastern versant.

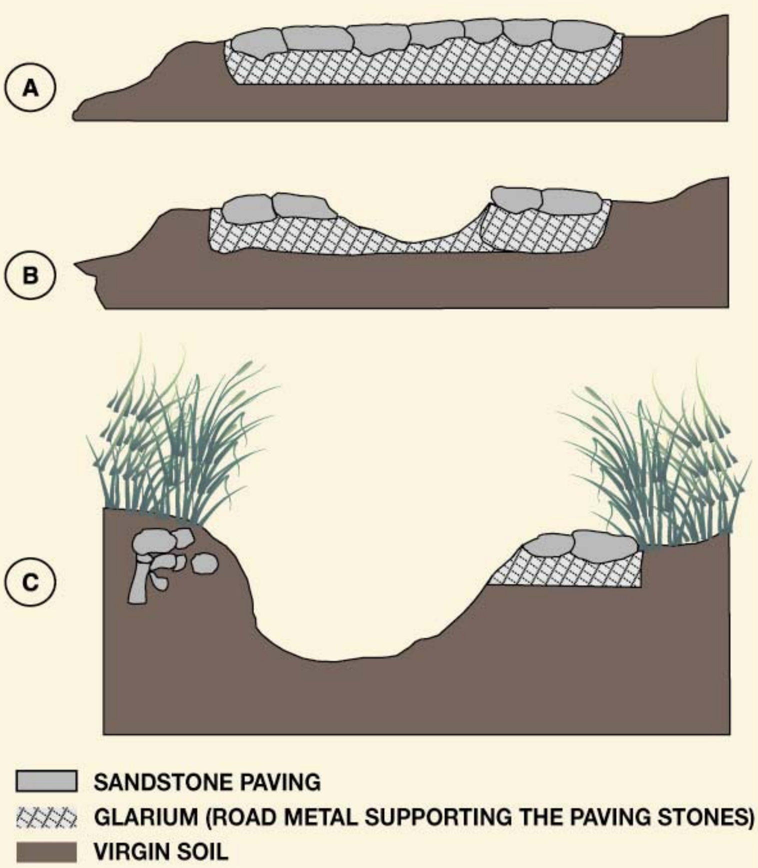

Plate 20
Mount Poggiaccio - site C/1: cross-section of the road.
B-A – Cross-section during construction.
B – Cross-section of the paved road partially uprooted by the passage of the mule-track and water erosion.
C – Cross-section of the road in its present condition: only a few stones remain in their original position.

SITE C/1

The first confirmation of the exactness of the direction we had chosen came when we identified traces of the ancient medieval mule track, which was very uneven and sunken in this point. By following the mule track, we found at its edge, about 100 metres south of the pass, near the original level of the wood, a number of aligned sandstone slabs, laid flat and with rounded edges, clear remains of the paved road. The mule track had clearly sunk deeper and deeper due to the centuries old

Mount Poggiaccio (site C/1): *three stones of the uphill edge of the paved road. The only survivors of the 2.40-metre wide paving, damaged and lost by the centuries-old passage of travellers and animals and by rainwater erosion.*

rainwater erosion[1], which had dispersed the entire width of the carriageway. Only a few stones of the original paving were still on their original level. This very modest find was fundamental because it proved that this was the direction to follow and it confirmed that the paved road continued along the Tuscan versant.

After re-finding the route of the road, which we had lost all trace of since the last find near Piana degli Ossi, we continued, carefully scrutinising the undergrowth on either side of the mule track and the vicinity to see if we could find even the smallest indication. We carried out numerous small test excavations on the downhill side where the road should logically have remained closer to the surface. By doing this we managed to identify a number of stretches on the lower slopes of mount Poggiaccio (site C/1), but we only uncovered the edge of the paving and did not extend our excavation to avoid losing time. We thought it would be more useful to uncover other stretches of paving towards the south to trace the exact route as far as the Futa pass.

SITE C/2

About three hundred metres after these finds we noted a number of stones on the downhill edge of the road which emerged from the dry leaves at the foot of robust beech trunks (site C/2). This was the only place where no excavation was needed to identify the paving. The woodland had taken over almost the entire carriageway and the tree roots had crept between the stones, penetrating as far as the layer of *glarium* below the paving.

These were relatively young trees (40-50 years old), the latest generation of the beech trees that had grown here during earlier centuries. The edge that emerged from the leaves coasted the adjacent mule track, which just a little further on, changed direction matching the ideal continuation of the straight line of the paved road. This was a good chance to investigate how the two routes interfered with each other and establish which was the oldest. In fact, if the paving continued intact, this meant it was built after the track was used in the Middle Ages. If, on the other hand, where it coincided with the mule track it was worn, broken up or had disappeared, this meant that it had been built before the track was used in the Middle Ages.

Mount Poggiaccio (site C/2-south): *the beech wood has covered the entire carriageway; just the downhill edge emerges from the dry leaves.*

We excavated along the right diversion of the mule track where no trees had grown, just a little further on from the beech trunks that covered the carriageway. The test excavation was carried out with great caution, and every stone uncovered was left in its original position to provide an overall view of the stones once the top soil had been cleaned away.

At the end of the work, a stretch of paved road (about eight metres long) emerged. The first five metres measured half the width of the carriageway, over last three metres it gradually narrowed towards the uphill edge, until it disappeared. The missing part of the carriageway corresponded exactly to the route of the mule track. Therefore, the partial lack of paving was caused by the centuries-old passage of travellers and animals after the paving had been built.

[1] The rain has had a determining effect in creating the sunken effect of the mule track located on top of the paving. Here the mule track follows the gradient of the slope and, therefore, the water erosion has been substantial even though the flow rate of the water is modest because of its location on the upper slopes of mount Poggiaccio.

In this area, the intact uphill edge looked as if it had been built with particular diligence. Whoever laid the stones took care to ensure they fitted tightly together, shaping the stones so that their edges matched to guarantee a perfect fit. Considering that this construction detail is still noticeable today in the parts that have not undergone subsequent repairs, it is easy to imagine how even and compact the paving must have been

Mount Poggiaccio (site C/2-north): *detail of the uphill edge of the road. Note how the stones of the original road are arranged with matching corners so that the sides match perfectly.*

Mount Poggiaccio (site C/2-south): *where the mule track and paved road coincide, the paving stones have been uprooted and have disappeared. However, the part of the paved road that did not coincide with the route of the mule track has remained intact.*

just after it was built. However, we did notice that the road paving was not always this perfect. Elsewhere, we noted less care was taken as to how the stones were arranged, perhaps because although the construction criteria were the same, some site foremen were less strict than others, allowing the paving to be laid although the edges of the stones did not match perfectly[2].

SITE C/3

Our search continued towards the Futa pass on the east versant of mount Poggiaccio, here we came within 400 metres south of site C/2, where the slope takes on a steep gradient. While carefully exploring this area, we noticed that uphill of the mule track, the slope decreased unnaturally for a length of at least 25-30 metres and a width of 2-2.50 metres. A small test excavation revealed numerous perfectly aligned stones that constituted the downhill edge of the road. As usual, we excavated at a right angle with respect to their alignment, uncovering the usual 2.40-metre wide paving. We followed the road and it was easy to uncover 15-20 metres of the lower edge, which was almost on the surface due to the slope of the ground.

Because of this particularly steep gradient below the road, we

[2] Lionel Casson: “Viaggi e viaggiatori dell’antichità”, published by Mursia, 1979, page 138: *“… Every now and then, for example, we find a piece of road of first quality followed by a long unpaved tract of mediocre workmanship; it looks very much as if expert army engineers did the first part and then, called away for some reason, left the locals to finish off”.*

Mount Poggiaccio (site C/3): *The downhill edge of the road has remained compact and in a straight line in spite of the fact that in this position, the mountain slope is very uneven.*

were surprised that the edge was still so perfectly aligned and had not collapsed. The road appeared to be well preserved over its entire width and the stones were still lying next to each other. Evidently, we had come across a particularly solid stretch. The mule track had not caused any damage because it passed about fifteen metres further down.

Mount Poggiaccio (site C/3): *the excavation highlighted the section of the road. The paving stones came from nearby quarries. The narrower part of the stones faced downwards so that they were more solidly embedded in the layer of* glarium *and offered better surface resistance to the knocks they received from above.*

The surprising state of conservation of the paving in site C/3 aroused our curiosity, to the point that we excavated a section of the entire width of the road to study its structure. In a certain sense, we were sad to move those stones, damaging the well-preserved paving, but our curiosity got the better of us and we agreed to carry out a small, one-metre wide excavation. We exposed the first stone on the downhill edge with caution and much effort, because it was tightly set among the surrounding stones. We then exposed the others, one by one. These offered less resistance to the pick, which we worked underneath the stones so we could lift them up, almost in awe: we felt as if we were being disrespectful to those who had toiled so much to lay the stones.

In summer 1988, in the presence of Luca Fedeli from the Superintendency, we extended the excavation we had started previously. Under the paving, in the middle of the layer of *glarium*, we found a small metallic object, very corroded by rust, apparently

Mount Poggiaccio (site C/3): *the section of paving showed that the narrow stones were laid vertically. On this stone, it is still possible to see the chiselling carried out when it was laid. We made the small white marks.*

shaped like a large pin. Unfortunately, it broke into three parts while we were removing it. We took the find to Giancarlo Susini, Professor of Ancient History at the University of Bologna, and, thanks to his intervention, Livio Follo, lecturer of Restoration Science and Technology

Mount Poggiaccio (site C/3): *metallic object (which turned out to be a nail) dating back to the 3rd-4th centuries B.C. found in the* glarium *while excavating the section of paving in the presence of Luca Fedeli.*

at the Advanced School of Archaeology at the University of Bologna, was able to identify its exact original form and date it to the 4th-3rd centuries B.C.[3]

It turned out to be a straightforward nail and not a pin or any other clothing accessory as we hoped. Therefore, it was an item of scant archaeological interest but anyway quite significant for our research. It was used in 300-200 B.C., that is before 187 B.C. the presumed date of construction of the road. Bearing in mind the position in which the nail was found, the two dates are chronologically compatible.

2 - The construction characteristics of the paved road

2.1 – The technique used to lay the stones

The section of road excavated on site C/3 illustrated the stratigraphy of the road. The sandstones are laid so that the sides of each stone matches the sides of the other stones; the widest are laid horizontally and are about 25-30 cm thick with a trapezoidal shape. The less thick ones are laid vertically and are often deeper set than the others. The larger and bigger stones are arranged along the edges, forming a type of curb which contains the smaller, central stones. Under the paving, there is a 20-25 cm layer of small sandstones of various sizes (*glarium*). These are obviously off cuts from larger stones from the nearby quarries[4] which were packed into the trench dug into the ground, and had a dual purpose: they formed a robust bed and offered drainage for rainwater.

Both the layer of "*glarium*" and the paving stones are set in the ground without any supporting walls on the downhill side, in spite of the fact that the road unwinds along the side of the ridge, cutting through the steep slope of the declivity. Undoubtedly, this construction technique, without any downhill supporting wall, provided certain stability to the carriageway, which could only collapse if the entire ground underneath was carried off by a landslide.

These structural characteristics, found in every unearthed stretch of paving, are profoundly different from the rare paved roads built along the mountaintops from the Middle Ages to the 19th century. These not only had a narrower carriageway, but were supported on the downhill side (when necessary) by dry stone walls or walls built using mortar which was very poor in lime. Another obvious characteristic is the shape of the stones: those laid horizontally are 25-30 cm thick. The upper part is wider than the bottom part, giving the idea of a roughly sketched wedge embedded in the layer below. This pseudo pyramid shape had two substantial advantages:

- only the upper part of the stones had to match perfectly because their sides did not touch; the empty spaces that remained between one stone and another below the surface were filled with *glarium*. This technique was a huge time saver because it was not necessary to square the side walls of the stones exactly

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[3] The results of the tests carried out by Livio Follo, whom we would very much like to thank, are indicated in his report dated 20/05/1989 (document 8).

[4] Here and there along the entire route of the paved road it is possible to see the remains of the nearby quarries from where the road building material was extracted, exploiting the frequent natural outcrops of sandstone.

to achieve perfect adherence between one stone and another on the upper part of the paving;
- unlike the parallelepiped, a pyramid shape guarantees better stability. In fact, because the reactions generated by the vertical loads are perpendicular to the oblique surfaces of the pyramid, they provide every stone with a horizontal push on all four surfaces. This guarantees that the stones maintain their original position, avoiding sideways movements, as well as any "rocking" action.

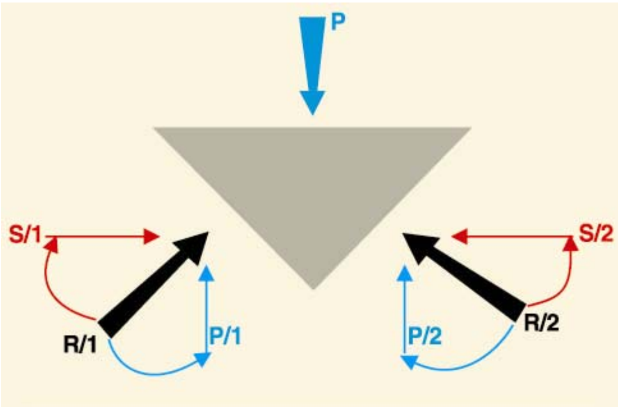

Plate 21
Mount Poggiacelo - site C/2: diagram of the forces opposing the vertical load when a stone with an upturned pyramid shape is used.

P: vertical load;
R/1 and R/2: perpendicular reactions on the inclined surfaces;
P/1 and P/2: vertical forces opposing the load above;
S/1 and S/2: horizontal forces.

Vertical load **P** generates the two R/1 and R/2 reactions, which are perpendicular to the inclined surfaces. Each can be broken down into two forces, one vertical (**P/1**) which opposes and balances the load above, and one horizontal (**S/1**) which opposes any side movement and the inclination of the stone. The example in the figure illustrates the case of one element with just two inclined surfaces; in practice, because we are dealing with an upturned pyramid, the advantage of the horizontal thrust is exercised on all four sides.

Mount Poggiaccio (site C/3): *a paving stone shaped like a pyramid with the point facing downwards.*

Remains of the Via Flaminia in Carsulae *near S. Gemini (province of Terni) (from “Le strade romane in Italia” by Daniele Sterpos, “Quadernidi Autostrade”, page 31). Note the pyramid shape of the stones.*

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[5] From a mechanical point of view, the advantages of the upturned pseudo-pyramid compared to the “slab” shape are two. The first, very intuitive, is that this shape eases insertion of each stone in the roadbed and, at the same time, it compacts the roadbed ensuring a stable road surface: the deeper the pyramid penetrates the more the roadbed is compacted.
The second advantage is that the paving is much more robust and the so-called "rocking" effect (typical of slab paving) is avoided. In fact, after repeated transit of loads, the roadbed in contact with the edges of the stone slabs becomes less compact, whereas the roadbed under the central part of the slab remains more or less intact. In the long-term, a hump forms below the slab which causes a “rocking” motion which unsettles the paving and causes some slabs to break.
(We would like to thank Alessandro Uberti for his technical advice).

2.2 – The work phases

We now believe it would be interesting to describe the road building process and calculate the amount of material extracted and used to build the road. We only refer to these stretches of paving[6] (*silice strata*) uncovered near the Apennine pass. The continuity of the find over a length of about 11 km, and the constant construction features allow us to base our reconstruction and the relative quantity calculations on objective and certain data.

The Romans undoubtedly encountered the largest difficulties when building the road along this barren and wild stretch of pass. As well as the hostile winter weather conditions, the legions had to face rough ground, stubborn trees deeply rooted into the ground (it is very rare to see a beech tree that has been uprooted because it has collapsed under the weight of the snow or ice).

The work required very organised building sites and synchronised work gangs to carry out the various tasks, which must have been grouped into six functions:

Route tracers: engineers and peg planters.

Tree clearers.

Excavators to dig the roadway and the trench for laying the roadbed and the paving.

Workers to extract the sandstone from the quarries.

Carriers to transport the extracted material to the building site.

Pavers.

The route tracers had the least heavy job, but undoubtedly the most important. They had to select a direct course which was compatible with the mountains terrain. This straight course proves that the route chosen was the best in terms of costs-benefits.

Cutting down the trees was much harder work[7] and had to be carried out before the excavators could start.

On flat surfaces, the excavators dug a trench about 50 centimetres deep; however, on hilly and mountainous terrain there are few stretches that feature a transverse line on ground level, or with a slight slope. Therefore, in rugged areas, such as the Apennines, they had to excavate a horizontal plane which considerably increased the amount of excavation required, also to provide the uphill embankment with a gradient that was unlikely to collapse without building supporting walls [8].

In these areas, the average depth of the excavation increased to a minimum of 70 centimetres, also due to the need to flatten small humps.

Because the width of the road had to be 2.40 metres, the roadbed excavation required the removal of at least 1.70 cubic metres of earth and stones for every linear metre, equal to about 30 tons.

Furthermore, all the difficulties that the workers must have encountered due to the presence of tenacious roots and rocky outcrops also have to be considered.

Having identified the layers of sandstone outcrops scattered throughout the area, a quarry was opened nearest to where the stones were to be used. First of all the ground had to be cleared of any large outcrops, any suitably sized rocks

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[6] As outlined later, the road was only paved where strictly necessary. Where the ground was solid and compact the road was built using just *glarea.*

[7] The wood not only had to be cleared in terms of the width of the road, but also to make way for the verges on either side. The Romans expropriated the land on which they built their roads as well as any adjacent land to create a verge of a certain width to ensure the route and the horizon was perfectly visible (also for security). Therefore, the clearing work was carried out in different widths according to requirements. Radke (Gerhard Radke: *Viae publicae romanae* published by Cappelli, Bologna, 1981, pages 22-23) mentions a quote from Strabo according to which during the mid 2nd century B.C., when the Romans were building a road in Liguria, they expropriated a verge measuring twelve “stadiums”. Therefore, it is likely that when building the transapennine road, the Romans forced an identical, if not broader verge on their enemies, particularly necessary due to the asperity of the area. Very probably, the entire area was cleared, reaching as far as the banks of the rivers that outline the slopes of the ridge along which the Romans built their road.

[8] We noticed that along the entire length of the road, there were no supporting walls, either uphill or downhill, in spite of the considerable gradient of the slope it often intercepted.

An important stretch of the Egnatia *consular road in Macedonia, built by the Romans in the 1st century B.C. which linked Durrës to Thessaloniki. Local material was used to build the road paving.*

were used to build the road; these could be large or small and were heaped at the edge of the trench within reach of the pavers.

Pavers were selected from the most skilled workers, able to judge at a glance the dimension and the shape of the stones so they could be laid tightly one next to another. They also had to be able to shape the sides of the stones and lay them so they were firmly embedded in the layer of *glarium* (prepared beforehand). They used three lines to ensure they followed the established route and to ensure the road was in a perfect straight line. Two lines indicated the edge of the paving and another indicated the middle of the road.

2.3 – The amount of material removed and used

Considering that the trench was filled with 50 centimetres of material (20-25 cm of *glarium* + 25-30 cm of stones), for every metre of road, about 1.7 cubic metres were used, corresponding to about 30 tons[9]. In fact, it is necessary to bear in mind that, even if the stones were laid with care and the *glarium* was well compressed, the small gaps that remained in terms of volume, reduced the overall weight by at least an estimated 30%. Therefore, it is correct to consider just 30 tons average weight of material used to build each metre of road. Thanks to this data, we can easily calculate how many tons of material were excavated, carried and laid to build one kilometre:

trench excavation work:

30 tons x 1,000 metres = 30,000 tons

extraction, carrying and laying the stones:

30 tons x 1,000 metres = 30,000 tons

total = 60,000 tons

Thanks to the archaeological proof that the paved road went from mount Bastione to

[9] Compact blocks of sandstone (pietra serena), weigh 27 tons per cubic metre.

mount Poggione along a continuous 11 km course, the weight of the excavation and construction material along this stretch alone was equal to 660,000 tons!

In the face of these figures, which refer to about one tenth of the route from Bologna-Fiesole, it appears obvious that such demanding and costly work can only be attributed to the organisational, economic any military power of Rome.

3 – Other finds (site C/4)

Even if our main objective was to find the road paving as far as the Futa pass, we did not fail to explore the areas next to the route and especially the nearby peaks. Thus, the peak and upper slopes of mount Poggiaccio did not escape our scrutiny. On the peak, at an altitude of 1,196 metres above sea level, we noted a hollow, undoubtedly a manmade defence, which can be dated back to the "Ligurian Castellars", the same as the one on mount Bastione and in Poggio Castelluccio.

Significant finds have confirmed the existence of very ancient settlements on the eastern and western slopes near the peak of mount Poggiaccio.

Mount Poggiaccio (site C/4): *ceramic fragments made of very rough and unevenly fired clay dating back to the 8th-4th centuries B.C. (which can be attributed to the Apennine-Ligurians) found in large numbers on the upper slopes of mount Poggiaccio.*

We were surprised to note that wherever we made a small test excavation, at a depth of 50-60 cm, unglazed ceramics emerged, typical of the Apennine-Ligurian civilisation. This abundance demonstrates that the area was inhabited by Apennine-Ligurians for a long time.

During one of our numerous explorations, where the slope decreases until it almost becomes horizontal, we noticed a slightly raised circle on the ground which reminded us of the perimeter of an ancient hut. We excavated thin horizontal layers around the perimeter. At a depth of 30-35 cm, we noticed the ground was a different colour; perhaps it was a faint trace of ancient pile-work. In fact, at a distance of about 5 cm it was possible to distinguish small, darker circles in the ground, with a diameter of about 5 to 8 cm, which appeared to be the organic remains of buried piles. We followed these indications and identified the perimeter of a hut, which did not appear to be perfectly circular. In fact, the diameter was 5 m from north to south and 4.5 m from east to west. However, it was easy to find the centre and we dug with care. At a depth of just 40 cm, we found abundant carbon remains, obvious testimony of the last fires lit by the ancient

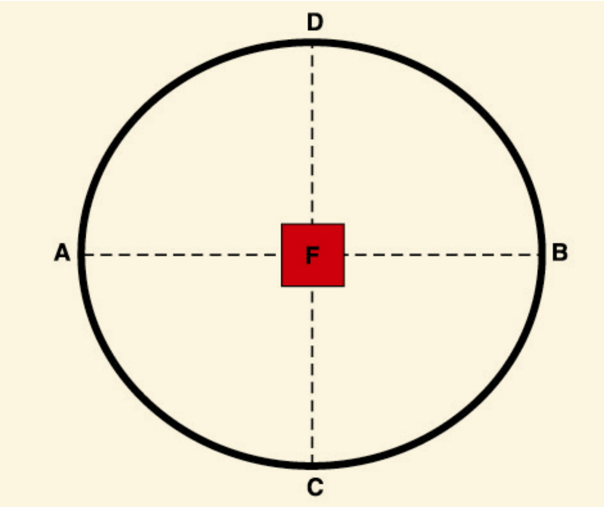

Plate 22

Mount Poggiaccio - site C/4: sketch of the hut circle dating back to 2200-1500 B.C. A-B = 5 m; C-D = 4.5 m; F: hearth with carbonaceous residues.

hut dwellers. There were not any stone remains resembling a hearth and due to the lack of any other significant remains, all we could do to get an idea of the age of the hut was date the carbon remains.

In July 1988, Agostino Salomoni from the ENEA C/14 Laboratory in Bologna, in the presence of Luca Fedeli, tested the carbon remains of the presumed central hearth of the hut. The results of the analysis dated the combustion date of the carbon as 1860 B.C. (give or take approximately 320 years)[10].

This result took our minds back to the onset of the bronze age and made us try to imagine what life was like for these resilient people and wonder how tough survival must have been on the inhospitable peaks of the Apennine ridge. Perhaps they were forced to settle here to defend themselves from their enemies more efficiently. We know nothing about them; perhaps they were the forefathers of the Ligurian tribes of whom archaeological proof has been found.

Drawing of a hut used by the Ligurian tribes (Archaeological museum of Ligurian civilisation in S. Remo).

In the surrounding area, we found a considerable number of oval shaped pebbles collected from the beds of the torrents and carried up on the peaks to be used as missiles.

Mount Poggiaccio (site C/4-August 1986): *excavation on the peak of mount Poggiaccio; Franco Santi in the pit helped by Francesco Ferrari, Cesare Agostini's nephew.*

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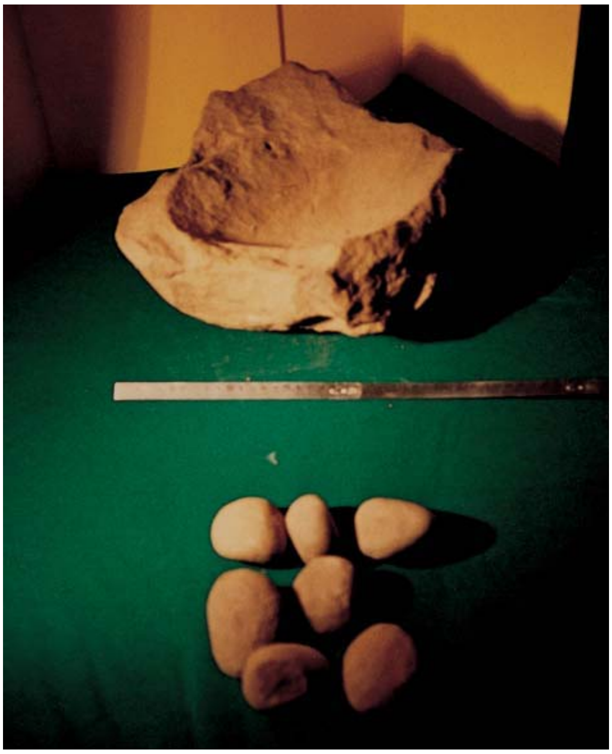
[10] The written certifications of these analyses were sent by ENEA to Luca Fedeli from the Archaeological Superintendency for Tuscany with a letter dated 23/05/1989 (document 5, sample BO 104).



Mount Poggiaccio (site C/4): *lytic mortar found on the peak of mount Poggiaccio dating back to the Apennine-Ligurians (8^{th}-3^{rd} centuries B.C.). Sandstone pebbles found in large numbers on the upper slopes of mount Poggiaccio. They were thrown by hand or using slings.*

Because of their shape and weight (about 200/300 g), they were particularly suitable for being thrown by hand or with a sling and were very likely an effective weapon for those times.

Considering that the Ligurian tribes lived in this area for centuries, it is likely that these missiles date back to this epoch. This is confirmed by another find: during a new excavation carried out on the peak of mount Poggiaccio, we found a large pebble-shaped piece of sandstone with notched edges, measuring about 30-32 cm in diameter. This is a lytic mortar, very similar to another in the Archaeological Museum of Ligurian Civilization in S. Remo dating back to the 8^{th}-5^{th} centuries B.C.

A lytic mortar very similar to the one found on the peak of mount Poggiaccio. (Archaeological museum of Ligurian civilisation in S. Remo – 9^{th}-3^{rd} century B.C.).